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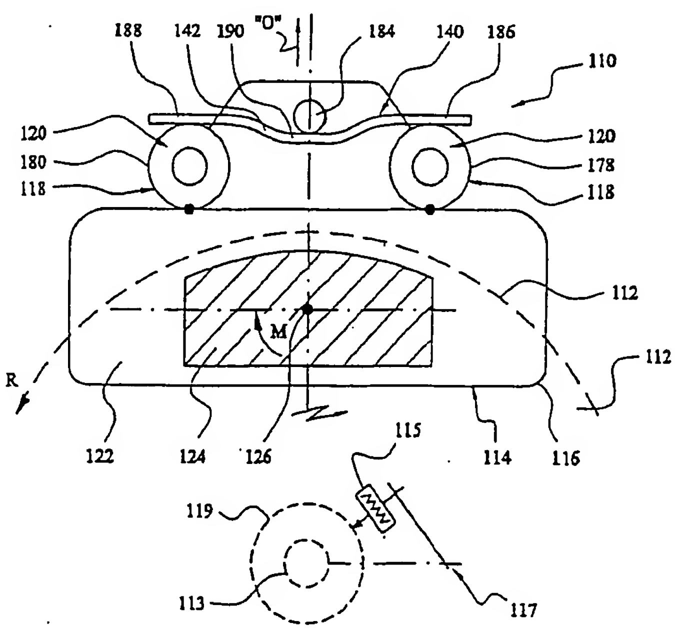
(54) Title: DEVICE FOR RETAINING FRICTION LININGS IN A DISC BRAKE



(57) Abstract: Method and apparatus for mounting a friction element in a spot-type automotive disc brake (10) provides resilient biasing means (40) to bias a slidable friction element (16) generally outwardly with respect to the brake disc (12) whereby the need for tight tolerances between the friction element and its guide means (18) is reducted by causing the biasing means to take up the tolerance gap which would otherwise be closed by the turning moment exerted on the friction element by the disc when braking commences.

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— *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*

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DEVICE FOR RETAINING FRICTION LININGS IN A DISC BRAKE

This invention relates to a method and apparatus (in the form of a disc brake) for mounting disc brake friction elements, particularly friction elements for spot-type automotive disc brakes but not exclusively so. In an embodiment described below the disc brake is of the kind in which at least one axially movably mounted rotatable brake disc is employed in association with a fixed or earthed caliper or mounting on which at least one friction element is slidably mounted. The brake may employ two or more slidable discs. The invention is also applicable to disc brakes of the kind employing a fixed disc and a movable caliper.

In the present application, references to "friction elements" are intended to refer to an element comprising friction material for frictional engagement with a rotatable brake disc, whether or not the friction material is provided additionally with a backing plate or other mounting. Where such backing plate or other mounting is provided, the term refers to the combination of the pad of friction material and the backing plate or other mounting.

In disc brakes whether of the fixed or slidable disc kind it is known to be desirable to provide means for controlling the movement and attitude of the friction elements both in the brake-off condition and in the instant of time which elapses between that condition and the engagement of the friction element with the rotating disc when the brake is actuated. For this purpose, There have been proposals for controlling the friction elements by the provision of resilient means such as torsion springs, and examples of such disclosures are to be found in:

GB 1533976 (Girling)

GB 2036211 (Lucas)

GB 2159221 (Sumitomo)

The above proposals and all others presently known to the applicants arrange matters so that the friction elements are resiliently biased generally inwardly with respect the rotating brake disc for the purposes discussed above. For example in the above-mentioned GB 976 specification it is stated at page 2, line 40 onwards, that "the outwardly extending arms of the spring exert resilient forces against the caliper member, the reaction to the sum of which forces at the spring attachment point on the backing plate thus pressing the friction pad assembly down on the guides in the torque member". It is added that the spring "acts both to prevent the friction pad assembly rattling in the guides in the torque member and to reduce the possibility of rattling occurring between the caliper member and the torque member". It is stated that this latter source of rattling is inherent in any sliding caliper disc brake as a clearance must be provided on the guides which control the sliding movement of the caliper member to ensure freedom from seizure or jamming.

Such an arrangement is known to the applicants to have become substantially standard practice in the industry. We have discovered however, that this arrangement is subject to a technical shortcoming which in certain situations and brake configurations can (contrary to the disclosure in the GB 976 specification) itself lead to the generation of noise and potentially wear and which might (when evaluated on the basis of conventional or obvious engineering techniques) lead to the adoption of tighter (and therefore more costly) tolerances, which are also undesirable from the point of view of the long-term freedom of movement of friction elements having regard to their conditions of use in a relatively dusty and dirty and

sometimes wet environment.

Turning to the GB 2159221A (Sumitomo) specification, this discloses a disc brake in which a slidable caliper (12) is slidably supported on fixed guide pins projecting from a fixed member (10) and twin pad-supporting arms (17) are provided at the outer or remote side of the rotatable disc from the hydraulic actuation system including piston (16). An inner friction pad is supported by the fixed member (10) and engages the disc on one side. An outer pad is supported by the caliper (12) and engages the brake disc on its outer side. The outer pad (19) has a backing plate with a projecting portion or bar (20) which lodges in correspondingly-profiled recesses formed in the twin pad-supporting arms (17) of the caliper outer portion against the radially-inwardly directed resilient action of a spring (24), so that the pad thereby is held in place by this inwardly-directed biasing force.

There is disclosed in EP 0 971 146 A2 (Sumitomo) a fixed disc brake in which special design features are adopted to suppress brake squeaks both during forward-travel braking and backward-travel braking. For this purpose, the pads (1) have lugs (10) at both ends of their back plates and these lugs are located in grooves (9) formed in guide portions (3) of a torque member (2). The guide grooves (9) are dimensioned so as to provide very substantial clearance which is sufficient to permit the location of liners (11) having resilient arms (12) which bias the pads at their disc-leading and disc-trailing sides so as to eliminate play and prevent rattling sounds.

Accordingly, the disclosed teaching in the EP 146 A2 specification amounts to the provision, for rattle and squeak reducing purposes in a disc brake of the fixed disc kind, of substantially enlarged clearances between the pads and their guides so that resilient liners can be inserted

in such gaps. Moreover these liners exert neither a net inwardly-directed nor a net outwardly-directed force on the pads, but a combined such effect whereby a torque is applied to the pads for such purposes. In contrast, the principal embodiment of the present invention seeks to provide a disc brake of the kind employing at least one axially slideable brake disc (thereby to provide access to the advantages inherent in such a system) and in which the shortcomings identified above in relation to previously-proposed pad or friction element-biassing systems are reduced or overcome. Thus, in the embodiments, the present invention provides a method and apparatus in which a generally outwardly-directed resilient bias is applied to at least one friction element whereby manufacturing tolerances are taken up by such bias even before brake application, thereby avoiding the necessity for the adoption of relatively tight manufacturing tolerances, and thereby by also avoiding the complexity of prior proposals utilising artificially enlarged clearances provided for the accommodation of resilient liners and the like. The embodiments of the present invention are able to employ relatively applied in a straightforward and mechanical way to the friction elements so as to achieve these advantages.

Moreover, the embodiments of the present invention adopt a yet further removed (from the prior art) approach to the application to the friction elements of their resilient bias in the following regard. As disclosed more fully below, the level of resilient bias is substantially increased beyond that needed for the anti-rattle and anti-squeak functions discussed in detail above in relation to the prior art. The level of bias applied in the embodiments of the present invention is preferably (and certainly in relation to the embodiments employing one or more axially-slidable brake discs) of an order of magnitude greater than

that required for this latter sonic function, so as to achieve the relatively unrelated mechanical function of friction element/pad attitude control (by virtue of face-to-face engagement of slidable attitude-defining surfaces), so as to maintain friction element parallel-alignment with the corresponding disc friction surfaces under the dynamic conditions of use. This function may be shortly referred to as an anti-tilt function. A complementary anti-tilt function is likewise provided in relation to the mounting of the slidable disc or discs in relation to the central mounting hub, by means of corresponding resilient means in the form of mounting springs.

An object of the present invention is to provide a method of mounting a friction element in a disc brake, together with a combination of a friction element and resilient biasing means therefor, and a disc brake incorporating same, offering improvements in relation to matters discussed above, or generally.

According to the invention, there is provided a method of mounting a friction element in a disc brake, and the combination of a friction element and resilient biasing means therefor for use in such a disc brake, and a disc brake incorporating same, as defined in the accompanying claims.

In an embodiment of the invention a spot type automotive disc brake comprises a rotatable brake disc and a mounting for the disc to permit such rotation. At least one pair of friction elements are provided which are adapted to frictionally engage braking surfaces on opposite sides of the brake disc to effect braking. Non-rotatable guide means is provided for at least one of the pair of friction elements to support same during its frictional engagement with the rotating disc and which also permits relative movement of the friction element towards and away

from the disc. Typically, the friction element in question is the one which is directly or semi-directly actuated by the piston of the brake's primary hydraulic actuation system.

Actuation means for the friction elements is provided to effect braking engagement of these with the brake disc in the embodiment. The actuation means comprises a primary hydraulic actuator provided in or on the brake caliper structure, whether the caliper is fixed or movable.

In the embodiment, the friction elements are provided with resilient biasing means acting thereon to bias at least the said one of the friction elements into engagement with a guide surface of the guide means, and that guide surface is located at least partially radially outwardly of the line of action of the actuation means. Typically, in the embodiments, the friction element is supported at a region located generally radially outwardly (with respect to the brake disc) of the central axis of the piston of the hydraulic actuator, although overlap of the circular periphery of the piston or cylinder with the guide surfaces (as viewed lengthwise of those guide surfaces) is a perfectly acceptable layout if so desired, and the references to "at least partially radially outwardly of the line of action of said actuation means" are to be interpreted accordingly.

Further in the embodiments, there is provided the characterising feature that the resilient biasing means is caused to bias the relevant friction element (or indeed friction elements in the case where more than one such guided element is provided, as is the case with a twin sliding disc brake) in a generally outward direction with respect to the axis of rotation of the brake disc. This arrangement has the following technical result. In the embodiment the biasing means exerts a turning moment on its

respective friction element which is in the same sense as the turning moment exerted thereon by the brake disc during frictional engagement of the friction element with the disc when the brake is actuated. In other words, the biasing means preloads the friction element in the direction in which it will be loaded upon actuation of the brake. As a result, tolerances adopted in the manufacture of the friction element and its mountings and indeed in the manufacture and assembly of the corresponding guide means, and which lead inevitably to at least some degree of freedom of movement in a direction which is generally lateral with respect to the direction of sliding movement of the friction element on the guides, is taken up before actuation of the brake and therefore when actuation occurs the relevant guide surfaces are already in engagement and there is no scope for initial relative movement on actuation of the brake, which would otherwise lead to noise and/or uncertainty of application, as is the case with prior art constructions.

In the embodiments, the resilient biasing means is provided in one case in the form of a torsion spring and in another embodiment in the form of a leaf spring, according to the convenience of connecting the spring structure to the adjacent parts of the brake. In the case of the torsion spring, the same direction of generally outward friction element bias is applied (through the central mounting of the torsion spring) to the friction element as a result of the spring loading applied during assembly.

It is envisaged that a friction element and its associated spring, together with (if necessary) an associated connecting structure such as a peg or pin, will be manufactured for sale and use as a replacement unit for brake servicing purposes.

In the embodiments of the present invention the disc brake incorporates resilient means both in relation to the mounting of the brake discs on their mounting hub and in relation to the mounting of the brake friction elements or pads in relation to their fixed mounting or caliper.

The resilient means are of a structure and strength chosen to be capable of, both in the case of the brake discs and in the case of the brake friction elements, maintaining these components of the brake assembly in their required working attitudes with respect to the structures on which they are mounted. In other words, the springs or resilient means for the brake discs are constructed so as to hold the brake discs in non-tilted working attitudes as they rotate. Likewise, the resilient means for the friction elements or pads maintain these latter structures in their required attitudes with respect to their fixed mounting or caliper. In both cases, the resilient nature of the resilient means permits, under the dynamic conditions arising during use of the vehicle and due to engine vibration and vehicle motion/road surface induced vibration and similar factors, a degree of movement from the defined working position (as opposed to the linear axial sliding movement needed to effect friction element-to-disc engagement and disengagement when commencing and terminating braking) wich is needed under normal conditions of vehicle use.

In this regard, it is to be noted that the resilient means or springs used in the embodiments in relation to the friction elements for maintaining same in their normal untilted attitudes, differ significantly from the springs disclosed in WO 98/25804 (docket 2561) and WO 98/26192

(docket 2558) in which the pad springs are mere anti-rattle springs not adapted to hold the brake pads against tilting movements, but merely to avoid rattling. Moreover, in the embodiments of the present invention the springs for the discs and for the pads are balanced in terms of their relative loading applied to the discs and the pads in order to achieve the necessary separation of same when braking is discontinued and yet holding the pads and discs against tilting during use. Thus, the spring forces exerted on the pads or friction elements of the present invention are much stronger than those needed merely to prevent rattling or noise suppression. The spring forces are sufficient to restrain the slidable brake pads or friction elements from moving into contact with the brake discs in an uncontrolled manner. The use of the substantially stronger pad springs in the present embodiments assists in positioning the outer rims of the brake discs in their brake-off position for reducing residual brake torque.

We have discovered that, contrary to the teaching in the above-identified WO specifications in which it is suggested that anti-tilt mounted discs are sufficient in themselves so far as disc/pad alignment is concerned, and all that is required for the pads is the provision of anti-rattle springs, further provision is desirable to reduce residual brake torque. We have now established that a significant reduction in residual torque can be achieved by the adoption of anti-tilt spring means for the friction elements. This feature preferably comprises the combination of resilient means in co-operation with face-to-face complementary attitude-defining surfaces on the friction elements and their guide means, and the arrangement being such that there is a co-operative effect with the anti-tilt mounted brake discs or discs such that the effect of dynamic factors arising during use including engine-and

road-induced vibrations leading to micro-scale interactions of the discs and friction elements after brake application produces a relatively well-defined backing-off of the pairs of axially-moveable structures (discs and friction elements) leading to well-defined clearance positions allowing relatively low level residual torque in which the haphazard torque-producing interactions characteristic of the relatively less well-defined friction element positions of the arrangement in the above-identified WO specifications are minimised or avoided.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:

Fig 1 shows a vertical section through an assembly of a disc brake friction element and an associated guide together with a corresponding leaf spring acting between the two in the direction taught by (but fig 1 is otherwise not in accordance with) the prior art, namely inwards with respect to the corresponding brake disc;

Fig 2 shows, in a similar generally vertical sectional view, an embodiment of the present invention in which the direction of spring bias is generally reversed;

Fig 3 shows, on a larger scale, and in exploded format, the friction element backing plate and associated leaf spring of the embodiment of Fig 2;

Fig 4 shows a modification of the friction element of Fig 3 for use with an associated torsion spring which is shown in assembled condition at 4A and in relaxed disassembled condition at 4B.

Turning first to the arrangement of Fig 1 which shows an assembly according to the teachings of the prior art, we mention first that the brake itself may be constructed in various ways and the structure shown in Fig 1 corresponds to that disclosed in our prior unpublished US patent

application number US09/303,183 filed 30 April 1999(docket 3115). For disclosure purposes in relation to a brake assembly to which the present invention maybe applied, we mention our prior published WO patent application number WO98/25804(Docket 2561) to which reference is directed and the entire disclosure of which is hereby incorporated herein for purposes of sufficiency of disclosure.

As shown in Fig 1, disc brake 10 comprises a disc 12 rotatable (for forward motion of the associated vehicle) in direction R and friction elements 14 adapted to engage opposite sides of disc 12 and comprising a slidably mounted friction element 16 carried on non-rotatable guide means 18 forming part of a fixed or earthed caliper or bridge structure 20 extending across the outer periphery of disc 12. Disc 12 is mounted for slidable movement on its rotation axis (not seen in Fig 1). Two or more discs 12 may be provided, each slidably mounted, according to design requirements.

As shown in Fig 1, friction element 16 comprises a profiled backing plate 22 having secured thereto and projecting outwardly therefrom a pad 24 of friction material for frictional engagement with disc 12.

Not shown in Fig 1 is a hydraulic actuating mechanism for brake 10, in which the piston (not shown) is extendable along about a generally horizontal axis 26 to engage backing plate 22 and cause pad 24 to engage disc 12.

Pad 24 has a curved upper profile 28 matching the circular periphery of disc 12 and spaced sightly inwardly thereof.

Backing plate 22 is formed with a mainly rectangular recess 30 to receive guide means 18 which has laterally projecting end portions 32, 34 of convex format to produce line contact at 36 and 38 with the edges of recess 30.

Resilient biasing means 40 in the form of a leaf

spring 42 acts between a mounting 44 on caliper 20 (centrally of the spring) and the edge surfaces 46, 48 of backing plate 22, to exert a generally downwardly-directed load on these latter surfaces, with respect to guide 18.

In use of disc brake 10, extension of the brake actuating cylinder's piston on axis 26 causes frictional engagement of pad 24 with the braking surface of disc 12 and the latter is caused to move slightly in the axial direction of the disc into frictional engagement with the fixed pad of the friction element (not shown)on the other side of the disc to engage the brake.

Frictional engagement of pad 24 with disc 12 causes the generation of a load on the friction element 16 having a notional load centre on axis 26. This load is resisted by the friction element where the same engages guide 18 at line-contact locations 36 and 38. Therefore, the load exerts a turning moment having a moment arm approximately as indicated at 50, the turning moment being generally clockwise with respect to axis 26 as indicated by arrow M. The result of this clockwise turning moment is the following. Although recess 30 formed in backing plate 22 is constructed so that caliper or bridge 20, and notably the end portions 32, 34, thereof are a sliding fit within the corresponding recess end portions 52, 54 there is inevitably (due to tolerances) some degree of working clearance as identified at 56 and 58. These clearances have been exaggerated for the purposes of illustration but in practice are nevertheless large enough to permit detectable movement. In reality, the effect is of some degree of relatively uncontrolled initial movement of the friction element and the generation of noise on initial application of the brake.

Turning now to the embodiment of the invention

illustrated in Figs 2 and 3, it is to be understood that this embodiment corresponds in structure to that described above with reference to Fig 1 except as mentioned below.

In the embodiment of Figs 2 and 3, parts corresponding to those of the structure described with reference to Fig 1 are given the same reference numerals increased by 100. Thus disc brake 10 becomes disc brake 110, disc 12 becomes 112 etc.

In this embodiment, the changes in structure are adopted in order to enable resilient biasing means 140 in the form of leaf spring 142 to exert a bias on friction element 116 in a generally outward direction (see arrow O) in contrast to the corresponding inward direction of bias in the structure shown in Fig 1 (see arrow I).

Accordingly, friction element 116 has a modified backing plate 122 comprising a projecting portion 170 formed with a waist 172 defined by concave recesses 174, 176 which are profiled to receive complementarily curved convex profiles of non rotatable guide means 118 having a caliper or bridge structure 120 comprising spaced individual guides 178, 180.

Resilient biasing means 140 comprising leaf spring 142 is in the form of a generally rectangular spring having a central slot 182 to receive the upper end 182 of projecting portion 170 of friction element 116 and to be retained with respect thereto by means of a laterally-projecting pin 184 incertable into an aperture in backing plate 122 to form the friction element 116 and spring 142 into a captive assembly.

As can be readily seen in Fig 2, the ends 186, 188 of leaf spring 142 bear on guides 178, 180 and the central portion 190 of spring 142 engages pin 184 on opposite sides of backing plate 122 to exert an outwardly-directed force in direction O thereon whereby the manufacturing clearances

between guides 178 and 180 and recesses 174, 176 are taken up, having regard to the direction of the moment of the force "M" exerted on frictional element 116 by disc 112 in use due to load centre 126 being below/inwardly of the loading location of friction element 116 on guide 180.

In Fig 2 there is also shown, diagrammatically, the mounting of brake discs 112 on their mounting hub 113. Discs 112 are axially slidable on hub 113 by means of a series of inwardly-projecting spaced-apart keys or dogs (not shown) which are axially-slidably engaged in corresponding keyways or grooves (not shown) formed in the outer periphery of hub 113. Resilient means 115 in the form of wire springs or leaf springs acts (as shown at 117 between hub 113 and the inner periphery 119 of each of the discs 112. In Fig 2 the relevant diameters for hub 113 and inner periphery 119 are shown smaller than to-scale for reasons of simplify of illustration.

As a result, when the brake is applied there is no click or other noise caused by the taking up of clearances and the friction element is at all times bearing on its guides and capable immediately of resisting braking forces with respect to forward motion of the corresponding vehicle.

In the embodiment of Fig 4, leaf spring 142 is replaced by a torsion coiled wire spring 192 mounted on pin 184 of friction element 116. The torsion spring 192 grips pin 184 so as to be capable of exerting its torsion effect on backing plate 122 through the pin. The spring arms 194, 196 engage on fixed projections 198, 200 of caliper 120 thereby to produce the required torsion effect, the degree of pre-load being indicated by the relaxed condition of spring 192 seen in Fig 4B. The direction of the moment arm of the torsion applied to friction element 122 is indicated by arrow M in Fig 4.

In use, the embodiment of Fig 4 operates substantially in the same manner as that of Figs 2 and 3.

In the above described embodiments the advantage is provided of retaining the effect of avoiding pad tilting by causing a spring to bias the friction elements into contact with their guides, but in addition there is the advantage that the reversal of the bias direction avoids the movement otherwise permitted (of the friction elements relative to their guides) by the taking up of manufacturing tolerances prior to engagement with the disc. The invention is readily applied to the friction element between two slidable brake discs in a twin disc sliding-disc disc brake and in such a case the spring could be its own torsion spring or (especially in the fig 2 and 3 leaf spring version) could conveniently be a common spring with that of another friction element.

Amongst other modifications which could be made in the above embodiments while remaining within the scope of the accompanying claims are the following. Firstly, where the invention is used in a brake incorporating two or more slidable friction elements then arrangements may be made for the spring effect on one of these to be different from that of the other. Such would be appropriate in the case of a friction element which is double-sided for interleaving between a pair of axially slidable brake discs. This can be achieved by the use of two springs of different stiffness or strength. Although the above embodiment have been exclusively spot-type disc brakes in which the friction elements are arranged to act on the braking surfaces of a brake disc at one sector of the inner or outer periphery of the rotatable brake disc, the invention may find application to non-spot type disc brakes in which the friction elements encompass an annular portion of the periphery of the rotatable brake disc and in such a brake

structure the requirement for minimisation of the movement arising on initial brake application also arises.

CLAIMS

1. A method of mounting a friction element in a spot type automotive disc brake, the disc brake comprising:

a) a rotatable brake disc;

b) a mounting for said rotatable brake disc to permit such rotation;

c) at least one pair of friction elements adapted to frictionally engage braking surfaces on opposite sides of said brake disc to effect braking;

d) non-rotatable guide means for at least one of said friction elements to permit relative movement of said friction element towards said brake disc;

e) actuation means for said friction elements to effect braking engagement of same with said brake disc;

f) said friction elements being provided with resilient biasing means acting thereon to bias at least said one friction element into engagement with a guide surface of said guide means, and said guide surface being at least partially radially outwardly of the line of action of said actuation means;

characterised by

g) said brake disc being axially slidable with respect to said non-rotatable guide means and said method comprising causing said resilient biasing means to bias at least said one friction element generally outwardly with respect to the axis of rotation of said brake disc.

2. A method of mounting a friction element in a disc brake characterised by causing resilient biasing means to bias a moveable friction element thereof generally outwardly with respect to the axis of rotation of a rotatable brake disc.

3. A method according to claim 1 or claim 2 charactered by said biasing means being adapted to exert a turning moment on said at least one friction element in the same sense as the usual turning moment exerted thereon by said brake disc during braking.

4. A method according to any one of the preceding claims characterised by said resilient biasing means comprising a torsion wire or leaf spring and the method comprising causing same to act between said at least one friction element and said guide means therefor.

5. A method according to any one of the preceding claims characterised by causing said resilient biasing means to apply a level of force adapted to maintain said friction element in an un-tilted attitude with respect to said non-rotatable guide means therefor during use.

6. A method of mounting a friction element in a disc brake substantially as described herein with reference to figs 2 to 4 of the accompanying drawings.

7. For use in a method according to any one of claims 1 to 6, the combination of a friction element and resilient biasing means therefor captively mounted thereon.

8. A spot type automotive disc brake comprising: a rotatable brake disc;

a. a rotatable brake disc;

b. a mounting for said rotatable brake disc to permit such rotation;

c. at least one pair of friction elements adapted to frictionally engage braking surfaces on opposite sides of said brake disc to effect braking;

d. non-rotatable guide means for at least one of said friction elements to permit relative movement of said friction element towards said brake disc;

e. actuation means for said friction elements to effect braking engagement of same with said brake disc;

f. said friction elements being provided with resilient biasing means acting thereon to bias at least said one friction element into engagement with a guide surface of said guide means, and said guide surface being at least partially radially outwardly of the line of action of said actuation means;

characterised by

g. said brake disc being axially slidable with respect to said non-rotatable guide means and said resilient biasing means being adapted to bias said at least said one friction element generally outwardly with respect to the axis of rotation of said brake disc.

9. A disc brake characterised by resilient biasing means adapted to bias a moveable friction element thereof generally outwardly with respect to the axis of rotation of a rotatable brake disc.

10. A brake according to claim 8 or claim 9 characterized by said biasing means being adapted to exert a turning moment on said at least one friction element in the same sense as the turning movement generated thereon by said brake disc.

11. A brake according to any one of claims 8 to 10 characterised by said resilient biasing means comprising a torsion or leaf spring adapted to act between said at least one friction element and said guide means therefor.

12. A brake according to any one of claims 8 to 11 characterised by said brake comprising two slidable brake discs and said at least one friction element being adapted to be mounted between said discs.

13. A brake according to any one of claims 8 to 12 characterised by said resilient biasing means being adapted to apply a level of force to said friction element to maintain same in an untilted attitude with respect to said non-rotatable guide means therefore during use.

14. A method of mounting a friction element in a disc brake substantially as described herein with reference to figs 2 to 4 of the accompanying drawings.

15. A spot type disc brake substantially as described herein with reference to figs 2 to 4 of the accompanying drawings.

16. The combination of a friction element and resilient biasing means therefor substantially as described herein with reference to figs 2 to 4 of the accompanying drawings.

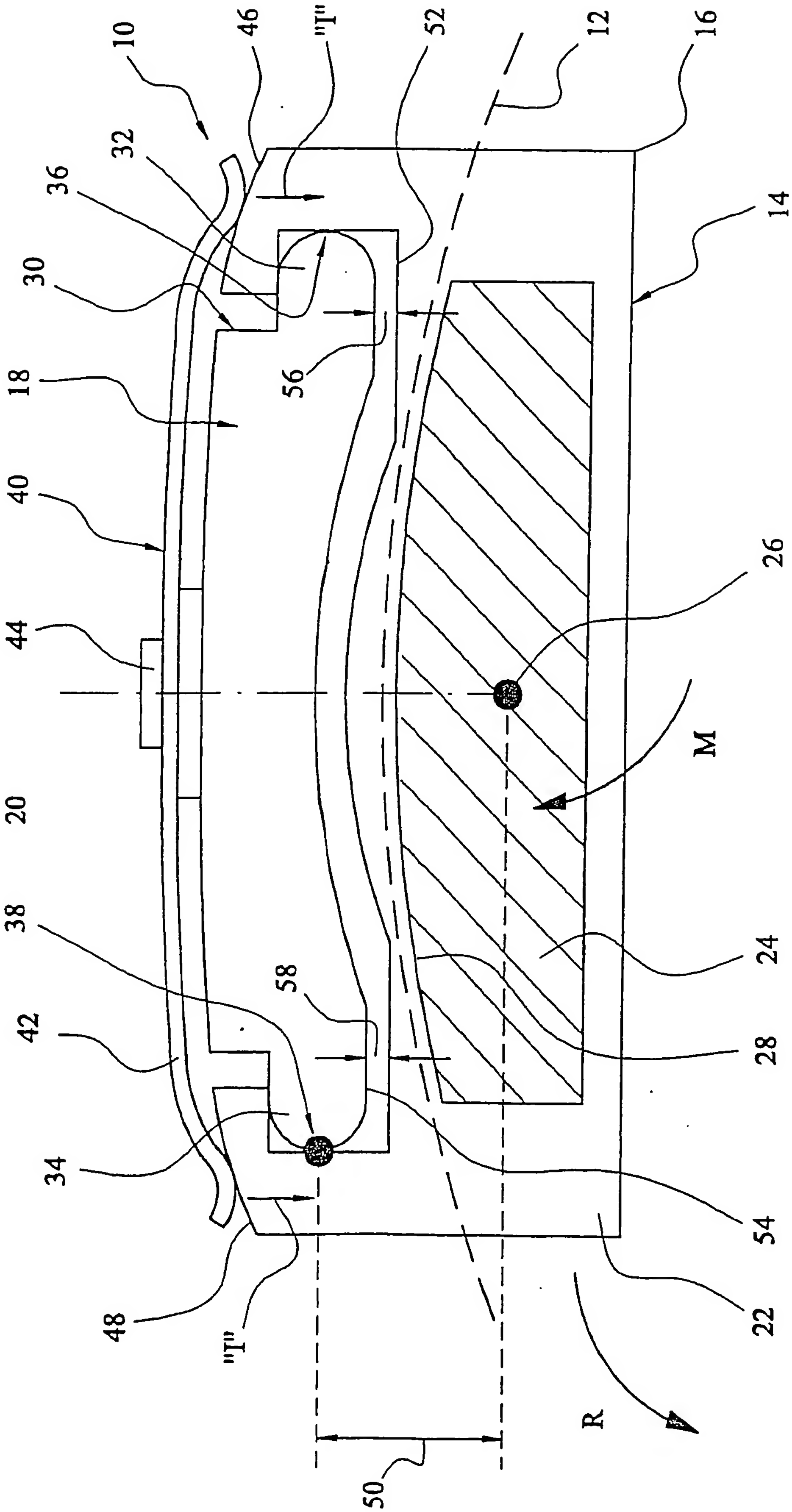
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FIG. 1

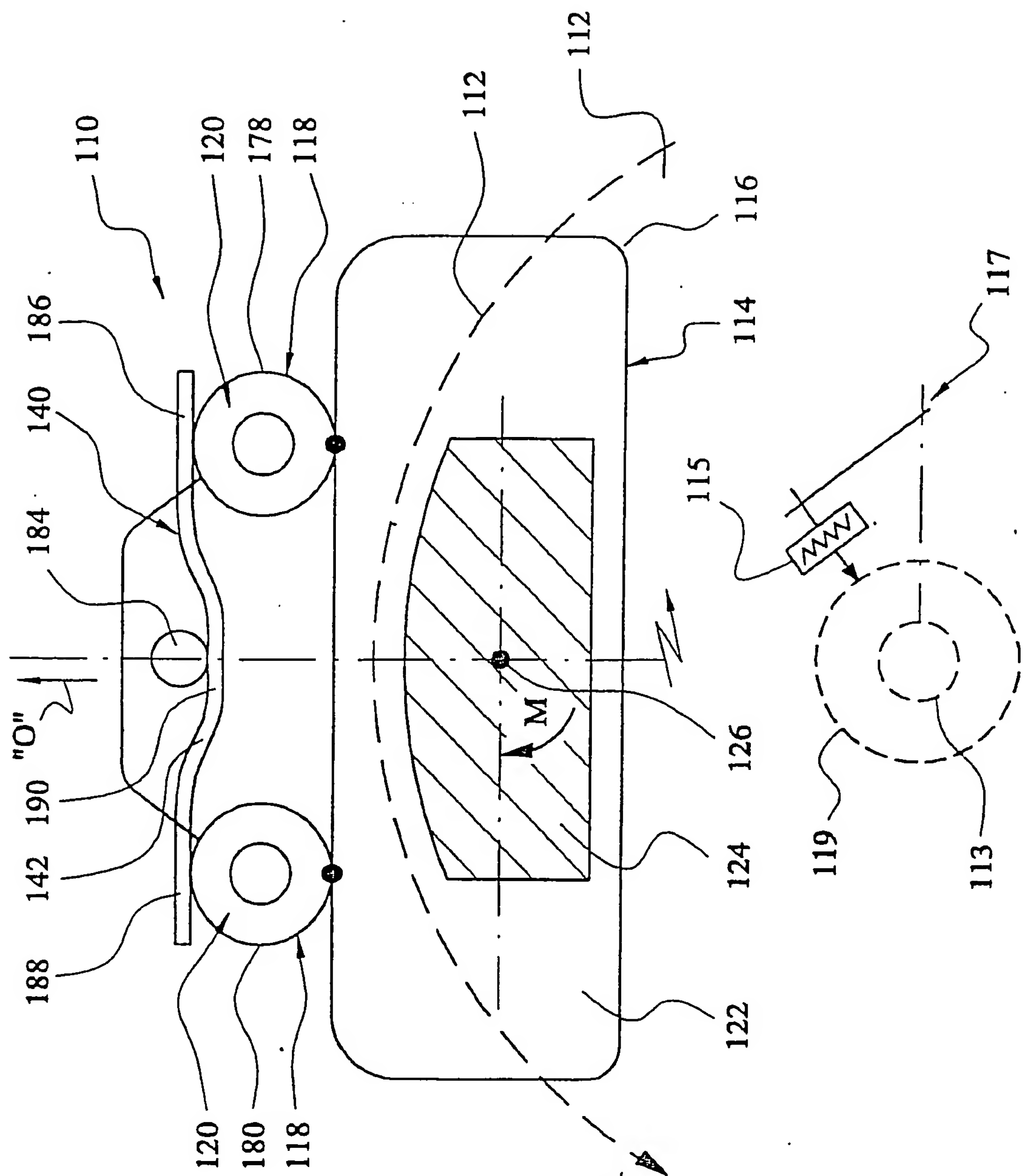
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FIG. 2

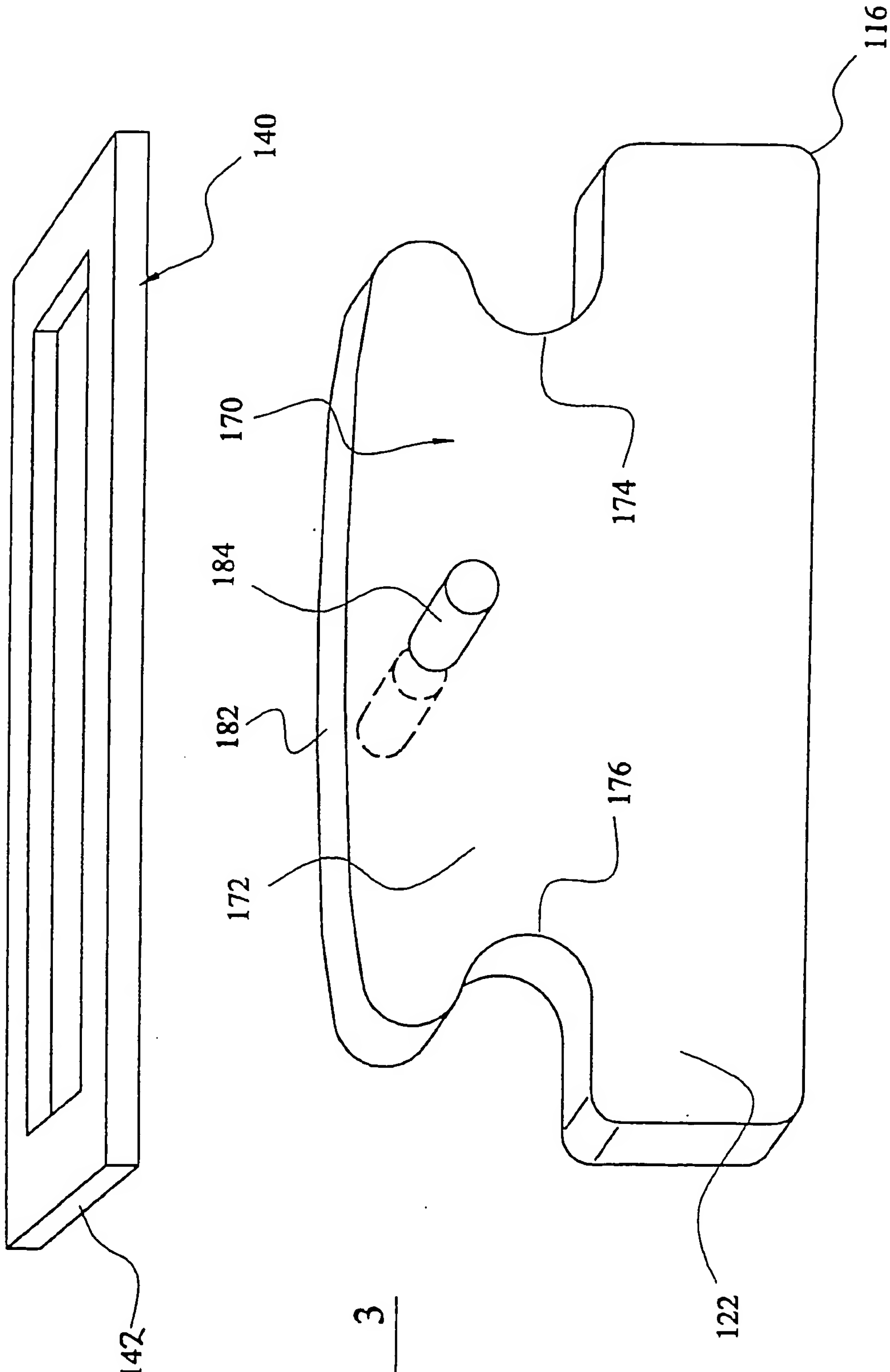

FIG. 3

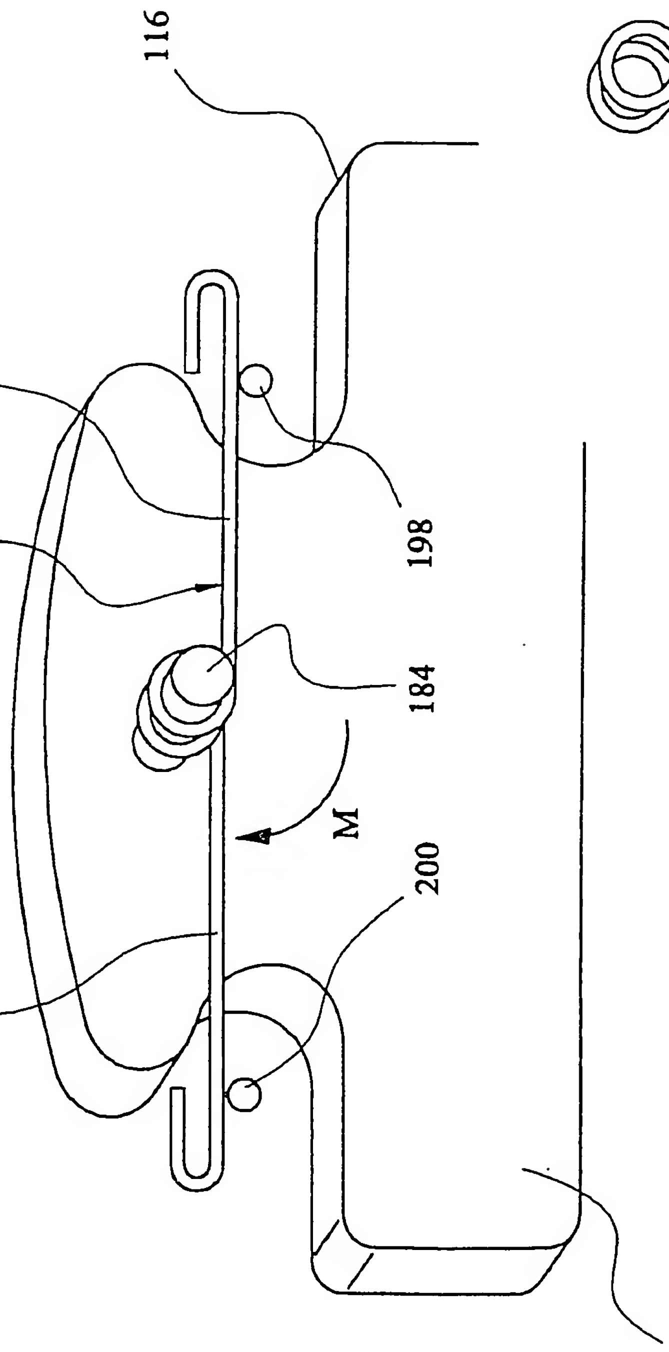

FIG. 4A

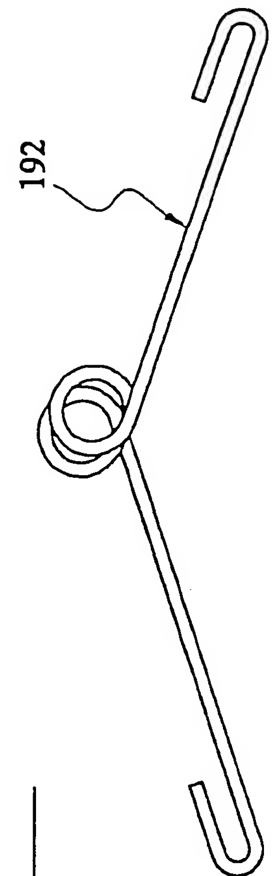

FIG. 4B

INTERNATIONAL SEARCH REPORT

Inter. ...nal Application No
PCT/GB 00/04334

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16D65/097 F16D55/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 049 845 A (LUCAS INDUSTRIES LTD) 31 December 1980 (1980-12-31) page 1, line 121 -page 2, line 46; figures 2,5,6 ---	1-16
A	US 4 844 206 A (CASEY GARY L) 4 July 1989 (1989-07-04) column 3, line 51 -column 5, line 30; figures 5,6 ---	1-16
A	US 4 606 439 A (MEYNIER GUY ET AL) 19 August 1986 (1986-08-19) column 5, line 32 -column 6, line 30; figures 2,4 ---	1-16
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 February 2001	05/03/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Topolski, J

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 941 348 A (MATSUMOTO TAKASHI ET AL) 24 August 1999 (1999-08-24) column 2, line 43 -column 3, line 14; figure 1	1-16

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 00/04334

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